Determination of Interfacial Kinetic Mechanisms during Crystal Growth by In Situ Measurement of Supercooling Versus Time

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Design and operation of systems used to grow high quality crystals from the melt can be greatly aided by knowledge of the kinetic mechanism of growth. Critical to the identification of growth mechanism is determination of the dependence of crystal growth rate, V, versus interface supercooling, ΔT. We present results of a combined experimental-theoretical approach used to determine the dependence $V(\Delta T)$ for $Bi_4Ge_3O_{12}$ (BGO).

The brightness temperature measurement method was used to measure supercooling vs. time at the solid-liquid interface, using an optical pyrometer to view the interface through the semi-transparent crystal [1]. Growth rate vs. time was determined by numerical simulation. In an earlier work, use of a one-dimensional radiation-conduction model predicted that the $V(\Delta T)$ dependence for BGO is sigmoidal, atypical of melt growth and suggestive of multiple kinetic mechanisms [2]. In the present work, we apply a two-dimensional transport model that includes thermal convection. Simulations reveal that thermal convection affects the growth rate, acting to suppress growth early in the experiment, and enhance growth later. When these refined estimates of growth rate are used, the $V(\Delta T)$ dependence for BGO has a conventional sublinear character, provided that the experimental data are corrected to account for emissivity of the crystal.

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